Urban Morph체雒슔M襟惨粧쏏膣劄跴刺 M襟忺聽a国ph磝硵M鬵聽蚌M襟硵M膤
main headline is how one should implement practical methods to tackle urban grov
simultaneously. How should one integrate urbanization and the issue of saving na
strategies could contribute to climate mitigation and emission reduction? Is urbar

to achieve a more sustainable result? A strictly sectorial approach could result in nec
of these demands. Conversely, an integrated approach can help to sharpen a better c
performances of different urban assessment.

systems, for improving the metabolism of the city as well as its energy performance. T
through prior publications by the authors; hence, the current paper solely focuses on on
method. Due to the fact that the majority of predicted urban growth will occur in mega
totalling 5% of the earth population, the article presents a case study Janeiro using the
improvements on the megacity of Rio de Janeiro.

K : Urban design; Urban planning; Sustainability; Energy; Urban environments

IMM R J

Main goal of this article is to demonstrate that the correlation between urban morphology and environmental performances is a key factor for achieving more sustainable results in the process of urban planning and design. Integrated Modification Methodology (IMM®) is a multi-scale and holistic method, which focuses on transformation of an existing urban system to an improved performing one in terms of environmental and social sustainability [1]. Considering the city as a Complex Adaptive System (CAS) is the main assumption of the IMM method; accordingly, cities are an arrangement of interconnected heterogeneous elements and the final result of the whole system is utterly different from every individual constituent's performance [2]. Each CAS is comprised of different elements or even smaller CAS's, whilst these elements and "sub-systems" have competence to learn from prior occurrences and experiences [3]. The mentioned learning feature creates adaptation competence of the system. The continuous adaptations occur to improve the system's performance in a response to new internal and external exposed constraints. CAS is a complex hierarchical configuration of different sub-systems and elements working together as a whole; therefore, the hierarchical nature of CAS requires a multi-scale approach if one intends to improve the entire system's performance [4]. Accordingly, designers should bare in mind that any particular sub-system includes other lower scale subsystems; whilst, it is part of an upper-system within the whole metabolism. Consequently, in order to transform upper-scale systems, IMM emphasizes on mid-scale interventions via lower-scale system's modification. Based on IMM, the transformation of an intermediate scale plays the catalyst role to initiate a chain reaction able to transform the entire structure of a CAS, whatever is the system's magnitude. Hew 0shtsd 0 Tw 5.247 0 0 5.247 401.2602 434.9337 Tm(®)Tj0.136 Tw 9 0 0 9 402.9445 431.9367 Tm(methodology to the selected case study.

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According to the recent Energy Information Administration (EIA), published in 2013, Brazil, as the 8th largest energy consumer in the World and third largest in the American continent, follows United States and Canada. Based on the same data source, although energy consumption per capita in Brazil is low in comparison with other leading economies, but the economic growth has stimulated the total primary energy consumption in the country in the past decade. Thus, Brazil has largely increased its total energy production, namely of oil and ethanol fuels and has become the 10th largest energy producer in the world [15].

The largest power sector of Latin America, Brazil, has reached a consumption of 455.8 TWh and an installed capacity equal to 113.7 GW in 2010 [11]. Concerning the generation mix, the Brazilian power framework is relatively fossil fuel free, characterized by a very strong predominance of hydropower which in 2010 accounted for 71 percent of the installed capacity and covered up to 78.8 percent of the electricity demand.

A detailed investigation and evaluation of the Rio de Janeiro environmental performances has been done by Latin American Green City, which ranked the city above the average index [16]. The Index assessed the environmental performance of 17 major Latin American major urban areas. The Index based on 31 individual indicators, assessed the performance of each city in eight different categories, respectively: energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality and environmental governance.

In particular, Rio finishes above average overall in the Index in environmental governance, thanks to a robust record on environmental monitoring and environmental management. Rio also performs sufficiently in the energy and CO_2 emissions as well; indeed the city's CO_2 emission from electricity usage is estimated around 73 kg per person. It is third of the seventeen cities' average of 202 kg. This appreciable performance is due to the considerable contribution of renewable energy to the city's electricity production (88 per cent of the Rio's electricity comes from renewable sources, primarily hydropower) [17].

Additionally, the city has achieved noticeably emerging above average results in the buildings categories; land use, transportation, waste, sanitation and air quality. However, it has a below average placement in the water usage and management category due to highest rate of water system leakages.

To emphasize that, it is helpful to highlight the actions and policies already put forth by Rio municipality to improve the city's energy performances and to address climate change and other environmental issues.

In 2009 the Municipality developed the city's 2016 Strategic Plan [12] consisting of 47 strategic initiatives, which directly contribute to sustainability of the city. The initiatives' spectrum covers 10 sectors, from Health, Environment transportation and etc. Then in 2011, the city ratified the Municipal Law on Climate Change and Sustainable Development [19,20], followed by the completion of voluntary inventory on Greenhouse Gas (GHG) emission [13]. A strategic document, which indicates potential directions to be taken towards greenhouse gas reduction, has been incorporated into the municipal environmental legislation. The document addresses different issues such as the implementation of Trans Carioca, Trans Olímpica and Trans Oeste bus rapid transit (BRT) corridors or the installation of a new waste treatment plant. To be precise, the Article 6 of the law set Rio's voluntary GHG emission reduction targets of 8%, 16% and 20% for the years 2012, 2016 and 2020, respectively, compared to 2005 emission levels (taken as a reference point for emission reductions ERs). This corresponds to cumulative reduction goals of 908 ktCO2e in 2012, 1,816 ktCO2e in 2016, and 2,270 ktCO_2e in 2020. In 2013 "The Rio de Janeiro Low Carbon City Development Program" (LCCDP) has been jointly developed by Rio de Janeiro's Casa Civil (City Hall) and the World Bank's Sustainable Development [19]. One should bear in mind that, even with all the GHG reduction strategies put in place, the GHG emissions still will rise in the coming years. This behavior is due to massive influx of investment, population growth and the economic activities, which are buoyed by the mega events that the city has organized in the period between 2014 and 2016 (Figure 7) [11,21,22].

P M N P

In order to evaluate the energy and environmental performances at the scale of the design area, numbers of Indicators, known as Design Ordering Principles (ODP) have been used. In particular the Indicators will be used again in different phase of the IMM process,

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to drive the local transformation, the Interface (Void+Transport) has been selected as the transformation's vertical catalyst. Interface has a direct relationship to movability inside the urban morphological cavities and the building blocks; it increases the morphological complexity of the system by increasing the number of possible Links to connect two nodes.

Morphological characteristics, which are driven from peculiar topographical features of the site is the main reason for the moderate degree of Interface. The urban morphology of Favelas (Morro Providência-Livramento and Morro do Pinto) with their narrow streets together with their hillside topographical features creates a physical barrier

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